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Effects of Green Tea extract on color and Lipid oxidation in Ground Beef Meat

Faisal A. Mustafa
Food Sci. Dept., Agric. & Forestry Coll., Mosul Univ., Iraq

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Correspondence: Faisal A. Mustafa Food Sci. Dept., Agric. & Forestry Coll., Mosul Univ., Iraq

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Abstract

The effects of green tea extract on relative concentration of myoglobin (Mb), metmyoglobin (MetMb) and oxymyoglobin (MbO2) forms and on peroxide values formation in ground beef meat was studied. Green tea extract(GTE) was mixed with ground meat (0.0, 0.5, 1.0, 1.5 and 2.0%) of meat weight. Samples stored for 1, 4, 8 and 12 days at 4 C°. There were significant differences ($P<0.05$) between control samples and samples treated with different levels of green tea extract in terms of myoglobin forms and peroxide values after storage under refrigeration. Treated samples with GTE developed low peroxide values compared with control and enhanced the proportion of each myoglobin form present. However, addition of 1 – 2 % of GTE to ground beef meat was adequate in reduced meat lipid oxidation and stabilized the meat color through decreased metmyoglobin (MetMb) formation after refrigeration

تأثيرات مستخلص الشاي الأخضر على اللون وأكسدة الدهون في اللحم البقري المثروم

فيصل على مصطفى
قسم علوم الأغذية – كلية الزراعة والغابات – جامعة الموصل – العراق

الخلاصة

تم دراسة تأثيرات مستخلص الشاى الأخضر على التراكيز النسبية للمايكلوبين والميت مايكلوبين والاوكسى مايكلوبين والرقم الهايدروجيني وكذلك قيم البيروكساید فى اللحم البقرى المثروم . مزج مستخلص الشاى الأخضر مع اللحم البقرى المثروم بنسبة (صفر, 0.5 , 1 , 1.5 و 2%) من وزن اللحم . خزنت العينات لفترة 1، 4، 8 و12 يوم بالتبريد على درجة 4 مئوى . اظهرت النتائج ان هنالك فروقات معنويه بين عينات المقارنة والعينات المعامله بنسب مختلفه من مستخلص الشاى الأخضر فيما يخص اشكال صبغة المايكلوبين والرقم الهايدروجيني وقيم البيروكساید بعد الخزن بالتبريد . العينات المعامله بمستخلص الشاى الأخضر أظهرت قيم بيروكساید واطئه وحسنت من نسبة صبغة المايكلوبين مقارنة مع عينات المقارنة. إضافة مستخلص الشاى الاخضر بنسبة لاتقل عن 1% الى اللحم البقرى المثروم كان فعالا لخفض تأكسد الدهون وثبات لون اللحم من خلال تقليل صبغة الميت مايكلوبين بعد الخزن بالتبريد .

الكلمات الدالة :
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Introduction

Ground meat is one of the most susceptible meat products for microbial contamination and lipid peroxidation during processing and storage, because grinding not only exposes more surface area of the muscle to air, but also accelerate the loss of intracellular reductants (Nam and Ahn, 2003). Green tea *Camellia sinesis* contains several groups of polyphenols that include flavonds, caffeine, phenolic acid, theanine, flavor compounds and leucoanthocyanins, accounting for up 40% of dry leaf weight (Graham, 1992). Catechins are the main bioactive constituents of green tea leaves and account for 25 – 35% of their dry weight (Sutherland *et al*., 2006). Tea catechin can act as antioxidants by donation of a hydrogen atom, as an accepter of free radicals, interrupting chain oxidation reaction or by chelating metals (Gramza *et al*., 2004). Free radicals, produced during lipid oxidation can oxidize haem pigment to metmyoglobin form causing discoloration of meat products (Karwowska and Dolatowski, 2007). Myoglobin, an oxygen binding protein found in muscle, is most responsible for the color of meat (Varman and Sutherland, 1995). Myoglobin exist in three main forms, myoglobin, metmyoglobin and oxymyoglobin, each producing a distinctive color. Storage conditions become more important in determining the proportion of each myoglobin form present (Warriss, 2000). Addition of green tea extract helped in prevention of metmyoglobin formation which stabilized the color of product during chilling storage (Karolina *et al*., 2011). The objective of this research was to determine the effects of green tea extract on lipid oxidation and color stability in ground beef meat stored under refrigeration.

Material and Methods

Sample Preparation: Fresh beef meat purchased from local market in Mosul city, was treated with addition of green tea extract. Green tea extract prepared by adding 1 gm. of dried green tea leaves (China importation) to 100 ml. of distilled water. Extraction hold on room temperature for 1 hour, followed by filterate the extract by whatman No. 1 filter papers. Green tea extract was mixed with ground beef meat at (0.0, 0.5, 1.0, 1.5 and 2.0%). Samples were formed as patties shape and placed in a tray, stored for 1, 4, 8 and 12 days at 4 C°.

Color Measurement: 10 gms. from refrigerated ground beef samples treated with different levels of green tea extract were blended for 1 min. in a waring Blender with 50 ml. of 0.04 M cold phosphate buffer, pH 6.8 and filtered through whatman No. 1 filter papers. The absorbance of the filterate was measured at 473, 507, 573 and 597cnm. using spectronic 20, Spectrophotometer. Relative concentration of myoglobin, metmyoglobin and oxymyoglobin were determined using the method of (Broumand *et al*., 1958).

pH values: The pH were determined by taking 10 gms. samples from each treatment mixed with 20 ml. distilled water, then measured by pH meter model WP 9421 (Phillips Scientific Co.).

Crude Fat: The total lipids were extracted from ground meat samples according to AOAC (1980). Method No.7056.

Peroxide Value: Test was measured on duplicate 5 gms. samples at each storage period (1, 4, 8 and 12 days) according to AOAC (1980) Method No. 28.023.

Statistical Analysis: The completely randomized design (CRD) was used for factorial experiment with two factors and the treatment were duplicate. After ANOVA table the means were tested by Duncan"s new multiple test at ($P<0.05$). (Hinkelmann and Kempthorne, 2008).

Results and Discussion

Table 1. showed that meat samples with addition of green tea extract had significantly ($P<0.05$) higher pH values compared to control samples, and this may due to green tea extract pH close to (7.70) as reported by Kobus-Cisowska *et al*., (2010). pH values obtained are agreed with the pH values (5.4 – 5.6) for fresh meat as reported by Varman and Sutherland, (1995). Also, Table 1. showed significant differences ($P<0.05$) for the four treatments levels of GTE added which caused an increased in myoglobin and decreasing in metmyoglobin relative concentration values that caused the enhanced of meat color. This results agreed with the results of Karolina *et al*., (2011) that the addition of green tea extract to meat helped in prevention of metmyoglobin formation. Also, added tea catechins (0.020%) can delay metmyoglobin formation during display of ground beef under both aerobic and modified atmospheric conditions as reported by (Tang *et al*., 2006).

Table 1. Means of pH and relative concentration of myoglobin forms for ground beef samples treated with green tea extract for 12 days of storage at 4 Cº.

Treatment	pH	Mb%	MMb%	MbO_2%
Control	5.69 a	34.70 a	33.89 a	31.41 a
0.5% GTE	5.83 b	37.09 b	33.38 a	29.53 b
1.0% GTE	5.85 b	47.81 c	22.85 b	29.34 b
1.5% GTE	5.87 b	51.71 d	22.73 c	25.56 c
2.0% GTE	5.80 b	55.08 e	21.88 d	23.04 d

a- Average values of two samples of each treatment.
b- Means in the same column (but not between) bearing a common superscript letter are not significant (P<0.05).
c- Mb = Myoglobin; MMb = Metmyoglobin; MbO2 = Oxymyoglobin and GTE = Green tea extract.

Table 2. showed no interference between green tea extract percent added and storage days on peroxide values. Control samples showed increased in peroxide values as storage days increased. Peroxide value of control treatment (1 day storage) agreed with peroxide value between (3.0-6.5) reported by Ali *et al*. (2008). The differences in increased peroxide values of (1.0 , 1.5 and 2.0 %) treatments for all different storage days were at low percent compared with control and (0.5%) treatment. This agreed with the result reported by Gheisari, (2011), that peroxide values increased in cattle, chicken and camel meat during refrigerated storage.

Table 2. The act of storage days and treatments on peroxide values (meq./Kg) in ground beef meat

Treatment	Storage at 4 Cº			
	1Day	4Days	8Days	12Days
Control	6.48 ± 1.89	9.09 ± 2.75	11.27 ±3.90	12.49 ± 3.29
0.5% GTE	2.35 ± 0.29	4.55 ± 1.98	5.49 ± 2.36	6.30 ± 2.60
1.0% GTE	1.30 ± 0.34	2.16 ± 1.16	2.77 ± 1.70	3.10 ± 1.87
1.5% GTE	1.07 ± 0.54	1.30 ± 0.79	2.18 ± 1.62	2.08 ± 1.53
2.0% GTE	0.86 ± 0.18	1.33 ± 0.84	1.85 ± 1.19	1.78 ± 1.45

a- Average values of two samples of each treatment for all storage days.

Table 3. Means of peroxide values (meq./Kg) during different storage days for all treatments. Means with the same letter are not significant (P>0.05).

Storage Days	Peroxide Value
1	2.41 b ± 0.78
4	3.69 ab ± 1.13
8	4.71 a ± 1.41
12	5.15 a ± 1.53

Table 4. Means of peroxide values (meq./Kg) upon the five treatments for all storage days. Means with the same letter are not significant (P>0.05).

Treatment	Peroxide Value
Control	9.83 a ±1.44
0.5% GTE	4.67 b ± 0.95
1.0% GTE	2.33 bc ± 0.59
1.5% GTE	1.65 c ± 0.49
2.0% GTE	1.45 c ± 0.42

Table 3. showed significant differences (P<0.05) in peroxide values between treatment (1 day storage) and treatment (12 days storage) which are (2.41) and (5.15) respectively, discarding the effect of GTE added to meat samples. This agreed as reported by Ivanov *et al*., (2010) that peroxide value for beef treated with natural antioxidant increased during chilld storage. The main effects of storage days did not affect peroxide values of ground beef meat significantly for the treatments 1, 4, and 8 days and this may due to low variation among treatments.

Table 4. showed levels of GTE added to samples are significantly (P<0.05) lowered the peroxide values compared to control samples. Duncan's multiple range test showed lowest means for peroxide values for treatment 1, 1.5, and 2.0% of GTE added which are (2.33), (1.65) and (1.45) respectively. There was no significant differences (P>0.05) between the last three treatments. Treatment (0.5%) gave peroxide mean value (4.67) as a second higher value compared with control treatment, which gave peroxide mean value (9.83) as a higher value. These results indicated that the GTE which contains compounds can lower the peroxide values which considered as a parameter for lipid oxidation in meat tissue. These results agreed with the finding of McCarthy *et al*., (2001), reported that the catechins present in green tea leaves was the most effective in reducing lipid oxidation in fresh and frozen pork patties. Mitsumoto *et al*. (2005) reported that adding tea catechins to minced meat inhibited lipid oxidation in both raw and cooked beef meat to a greater extent.

In conclusion, the addition of GTE was highly effective in reducing lipid oxidation and the perception of rancidity, also delay metmyoglobin formation which stabilized the color of ground meat during refrigeration. We recommend used GTE with ground beef meat not less than 1% at storage to enhance color and lipid oxidation stability which are very important attributes of meat products.

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